NASA TECH BRIEF

Compact, Electromagnetic Multiple-Stream Pump for Liquid Metals: Design Concept

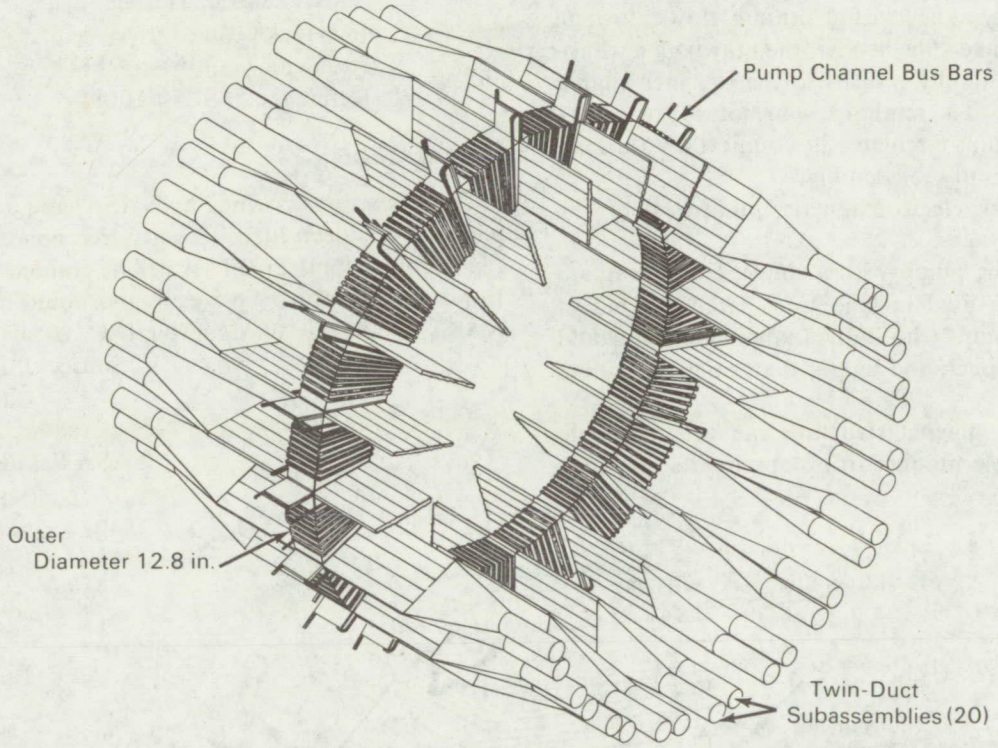

Figure 1. Liquid-Metal Pump for Uninsulated In-Core Thermionic Diode

A design has been proposed for an electromagnetic pump that would provide multiple, independent liquid-metal (e.g., molten lithium) streams, each at a uniform flow rate. This pump, intended to complement a conceptual in-core thermionic diode nuclear reactor concept, would replace 40 conventional electrically and hydraulically independent electromagnetic pumps.

The proposed compact pump design (Figure 1) employs a toroidal electromagnet with multiple, symmetrical, dual-pumping subsections. Each subsection comprises a two-pump duct sandwich, with the ducts being electrically insulated from each other and from the magnet pole faces by 10 mils of alumina ceramic (Figure 2). The magnet copper windings (Figure 3) which are electrically in series with the pump duct, are also insulated with a 10-mil coating of alumina. The noncritical electrical insulation requirements of this pump practically obviate any radiation damage to the

(continued overleaf)

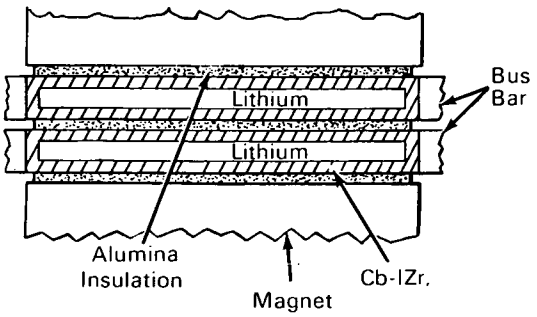

Figure 2. Cross-Section of Liquid Metal Pump Subsection

insulation and therefore allow the pump to be placed close to the reactor, if required, without undue degradation in performance.

Liquid lithium (or other molten metal) flows to the pump in 5/8 inch tubing (Figure 3) and then through a transition section which feeds a 5-flattened-tube header assembly. The exiting lithium flows through another 5-flattened-tube header, then through a transition piece, and finally returns to the 5/8 inch piping in the system. To minimize "armature reaction" effects, the lithium circulates in counterflow through the twin-duct pump subassembly.

The proposed electromagnetic pump offers the following advantages:

1. Since only one pump with a single, common magnet would be used in place of a large number of individual pumps with individual magnets, it would be more compact, and lighter than small individual units.
2. The toroidal magnet structure can accommodate any reasonable number of pump circuits that may be required.
3. The power requirement of this dc electromagnetic pump is well-suited to the output voltage of the basic thermionic diode output (low voltage, high current).
4. Magnetic flux losses are minimized; the mass of the magnetic structure is more closely positioned to the liquid-metal pump ducts, and a minimum number of series-stacked ducts is used per pumping section.

Notes:

1. Applications for this pump design would be in various liquid-metal-cooled space-power conversion systems and in systems requiring uniform, multiple, liquid-metal flow streams for feeding or cooling nuclear or chemical process units.
2. Requests for further information may be directed to:
   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: TSP70-10090

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to NASA, Code GP, Washington, D.C. 20546.

Source: J. P. Davis of
Caltech/JPL
under contract to
NASA Pasadena Office
(NPO-10755)

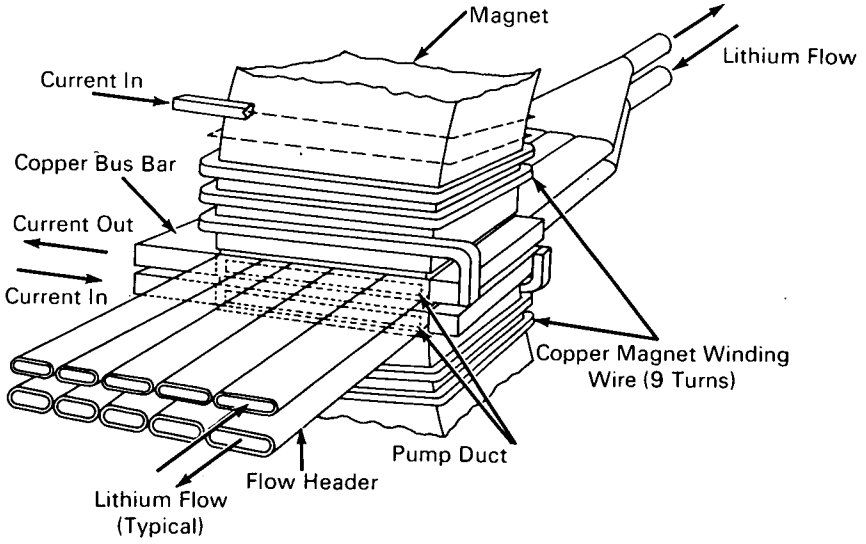

Figure 3. Typical Twin-Duct Pump Section